

- (21) Application No. 21753/70 (22) Filed 6 May 1970  
(23) Complete Specification filed 5 May 1971  
(44) Complete Specification published 30 Jan. 1974  
(51) International Classification B01F 13/00 B02C 15/00  
(52) Index at acceptance  
B1C 19G3 8 9  
B2A 10A 10C 10E 10H 10K  
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## (54) IMPROVEMENTS IN OR RELATING TO MIXING DEVICES

(71) We, RUBBER & PLASTICS RESEARCH ASSOCIATION OF GREAT BRITAIN, a British Company, of Shawbury, Shrewsbury, Shropshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention concerns mixing devices.

According to the present invention, a mixing device comprises a pair of coaxially arranged chambers which are interconnected by means of a plurality of clearance passages formed between a set of radially extending rollers and two annular supporting raceways therefor, means for effecting relative rotation of the rollers and the raceways, and means for introducing material to be mixed to one of the chambers in a manner to force the mixture through said clearance passages between the rollers and the raceways. The rollers can be cylindrical, in which case a suitable cage would be provided, but preferably they are tapered.

In a preferred embodiment, a second set of rollers is provided, the individual rollers of which extend radially between a second pair of coaxial chambers, with the latter chambers interconnected by a plurality of clearance passages formed between the second set of rollers and a pair of annular raceways therefor, the two radially outer chambers of said two pairs being connected together by means of an annular passage whereby the mixture is caused to pass through both sets of rollers in its passage through the mixing device.

The means for introducing material conveniently comprises a screw-conveyor which is rotatable within a cylindrical casing to transport material from a material input to a radially inner of the first pair of chambers.

The invention will be further described, by way of example, with reference to the drawing accompanying the Provisional Specification which is an axial section through one embodiment of a mixing device

constructed in accordance with the present invention.

The mixing device includes a helical screw conveyor 10 which is mounted for rotation within a cylindrical casing 12, one end of the conveyor 10 being journaled in an end wall 14 of the casing 12 and the other end being journaled within a cylindrical chamber 16 which is of greater diameter than the casing 12 but which is joined to the casing 12. The joint between the conveyor 10 and the end wall bearing is sealed by a gland 18 to ensure that all material introduced into an input port 20 located at the end of the casing 12 adjacent the end wall 14 is carried through the casing 12 by the conveyor 10. The end of the screw conveyor 10 projecting from the end wall 14 of the casing 12 is connected to a drive mechanism (not shown) whereby the conveyor can be rotated, preferably at a constant speed.

The end of the screw conveyor remote from the end wall 14 carries a circular disc 22 which is located within the cylindrical chamber 16 by means of two bearings 24, 26 each of which comprises two flat frusto-conical raceways 30, 32 and 36, 38 and a plurality of tapered rollers 40, 42. The bearing 24 is located between the disc 22 and one end wall 28 of the casing 16, with its one conical raceway 30 joined to the disc 22 for rotation therewith and its other raceway 32 joined to the fixed end wall 28 of the casing 16. The arrangement is such that an annular chamber 60 is formed radially inwardly of the rollers 40, between the rollers 40 and the shaft 10 of the screw conveyor, material being conveyed to this chamber 60 by the conveyor from the input port 20. Furthermore, an annular chamber 62 is formed radially outwardly of the rollers 40, between the rollers 40 and the internal cylindrical wall of the casing 16.

The bearing 26 is located between the disc 22 and the other end wall 34 of the casing 16 with its one conical raceway 36 joined to the disc 22 for rotation therewith and its

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other raceway 38 joined to the fixed end wall 34 of the casing 16. Adjacent ones of the tapered rollers 40, 42 are in longitudinal contact at their peripheries. Thus, a pair of clearance passages of roughly triangular cross-section are defined between each pair of adjacent rollers and the corresponding supporting raceways. As in the bearing 24, chambers 64 and 66 are formed radially inwardly and radially outwardly of the rollers 42, respectively. An annular passage 44 is formed between the peripheral surface of the disc 22 and the side wall of the casing 16 which passage 44 connects together the chambers 62 and 66 and hence connects together the clearance passages of the bearing 24 with those of the bearing 26.

The chamber 64 at the radially inner ends of said clearance passages of the bearing 26 communicates with an annular passage 46 formed between the race members of the bearing 26 and a cylindrical extension 48 of the shaft of the screw-conveyor 10. This cylindrical extension 48 terminates in a conical portion 50 which cooperates with a screw-threaded tapered plug 52 having a nozzle 54 to provide an adjustable output for the device as will be hereinafter more fully explained.

The cylindrical casing 16 is joined to the casing 12 by means of an annular flange which forms the end wall 28 of the casing 16, the connection being made by a number of screws 56 and spring washers 58 which serve to maintain the rollers and raceways of the two bearings 24, 26 in contact.

In use, the conveyor 10 is rotated at a constant speed whereby the rollers 40, 42 are also rotated by virtue of rolling contact with the rotating raceways 30, 36 respectively. Roughly premixed material is introduced into the casing 12 by way of the input port 20 and is conveyed along the casing 12 towards the disc 22 by the screw conveyor 10. When it reaches the chamber 60 of the bearing 24, the axial path of the material is blocked by the disc 22 and the material is forced radially outwards through the clearance passages formed between the rollers 40 and their raceways 30, 32 and into the chamber 62. During this passage through the rollers, an intensive milling and mixing action takes place which results in a thoroughly mixed and dispersed material.

The material is then forced through the annular passage 44 to the chamber 66 from which it passes radially inwardly through the clearance passages between the rollers 42 and their raceways 36, 38 to the annular chamber 64 during which the material is again subjected to an intensive milling and mixing action. The material then passes along the passage 46 and is finally discharged through the output nozzle 54. The nozzle 54 is screwed into the end of the

casing 16 so that the clearance between it and the conical extension 50 can be varied whereby the back pressure in the casing 16 can be adjusted to control the throughput of the mixer and to increase or decrease the time for which the material is subjected to the milling action.

In the event that increased mixing is required with high throughput rates, further disc 22 and further sets of raceways and rollers can be mounted on the end of the conveyor shaft so as to be in series with those shown in the illustrated embodiment.

The screw-conveyor 10 may be replaced by any other suitable means for introducing the material radially inwardly of the first bearing 24 so that it is forced outwardly through this bearing 24.

Although tapered rollers are preferred, they could be replaced by parallel cylindrical rollers held in a suitable cage. For mixing certain materials, it is advantageous to surround the casing 16 with a cooling water-jacket.

Although the disc 22 is shown as being separate from the adjacent raceways 30 and 36, these members can of course be integral.

#### WHAT WE CLAIM IS:—

1. A mixing device comprising a pair of coaxially arranged chambers which are interconnected by means of a plurality of clearance passages formed between a set of radially extending rollers and two annular supporting raceways therefor, means for effecting relative rotation of the rollers and the raceways, and means for introducing material to be mixed to one of the chambers in a manner to force the mixture through said clearance passages between the rollers and the raceways.

2. A mixing device as claimed in claim 1 in which the rollers are tapered.

3. A mixing device as claimed in claim 1 in which the rollers are cylindrical.

4. A mixing device as claimed in claim 2 or 3 in which adjacent rollers are in longitudinal peripheral contact whereby pairs of said adjacent rollers define two said clearance passages with the raceways.

5. A mixing device as claimed in any of claims 1 to 4 in which a second set of rollers is provided, the individual rollers of which extend radially between a second pair of coaxial chambers, with the latter chambers interconnected by a plurality of clearance passages formed between the second set of rollers and a pair of annular raceways therefor, the two radially outer chambers of said two pairs being connected together by means of an annular passage whereby the mixture is caused to pass through both sets of rollers in its passage through the mixing device.

6. A mixing device as claimed in any 130

- of claims 1 to 5 in which said means for introducing material comprises a screw-conveyor which is rotatable within a cylindrical casing to transport material from a material input to the radially inner of the first pair of chambers.
7. A mixing device as claimed in claim 6 in which the screw conveyor includes a shaft which extends coaxially through the, or each, radially inner chamber and which carries one raceway associated with the, or each, roller set for rotation therewith, whereby, when the shaft is rotated, said one raceway, or raceways, is rotated relative to the other to bring about rotation of the rollers located therebetween.
8. A mixing device as claimed in claim 7 when dependent upon claims 5 and 6 in which a disc is coaxially mounted on the conveyor shaft, each side of the disc carrying a respective raceway associated with one of the two sets of rollers, the other raceway associated with each roller set being rigidly fixed.
9. A mixing device as claimed in claim 8 in which the raceways carried by the disc are integrally formed therewith.
10. A mixing device as claimed in claim 5 in which one or more further sets of rollers mounted between respective further pairs of raceways are provided, the clearance passages defined by which being arranged to be connected in series with those of the first and second sets.
11. A mixing device as claimed in any previous claim in which an adjustable nozzle is provided at the final outlet of the device by means of which the back pressure within the device can be adjusted to control the throughput thereof and to control the time for which the material is subjected to the mixing action.
12. A mixing device as claimed in any previous claim in which the, or each, set of rollers and their associated raceways are all contained in a cylindrical housing.
13. A mixing device constructed, arranged and adapted to operate substantially as hereinbefore particularly described with reference to and as illustrated in the drawing accompanying the Provisional Specification.
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